

1 What is claimed is:

2 1. An electrically programming & sensing unit for a field repairable system-on-a-  
3 chip (SOC) device, said electrically programming & sensing unit comprising:

4 a diode such that a cathode of said diode is connected to a VDD power;

5 an electrically programmable element with a first end connected to an anode of said  
6 diode and to a VPP power;

7 a pull-down transistor configured to conduct current from said VDD power or from  
8 said VPP power to ground through said electrically programmable element when turned on;

9 a latch configured to latch a value from a second end of said electrically  
10 programmable element; and

11 a multiplexor configured to receive a set of external inputs and to control the  
12 operation of said pull-down transistor based on said set of external inputs.

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14 2. The electrically programming & sensing unit of claim 1, wherein said  
15 electrically programmable element has an initial state that is one of a high resistance and a  
16 low resistance and has a programmed state that is the other of said high resistance and said  
17 low resistance.

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19 3. The electrically programming & sensing unit of claim 2, wherein a turn-on  
20 resistance of said pull-down transistor is substantially at least 10 times of said low resistance  
21 and is substantially at maximum  $1/10^{\text{th}}$  of said high resistance.

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1           4.     An electrically programmable circuit for a field repairable system-on-a-chip  
2     (SOC) device, comprising:  
3           a high voltage generator configured to supply a VPP power in response to a  
4     program\_enable signal;  
5           a scan chain configured to receive address bits indicating whether a redundant row or  
6     a column needs to be activated;  
7           an electrically programming & sensing unit configured to receive a signal from said  
8     scan chain, said program\_enable signal, and a power-on-reset signal such that upon activation  
9     of said program\_enable signal, said electrically programming & sensing unit further  
10    configured to be programmed in response to said signal from said scan chain indicating a  
11    defective row or column should be fixed; and  
12           a fuse-switch configured to receive an output of said electrically programming &  
13    sensing unit such that said electrically programming & sensing unit is able to  
14    activate/deactivate said fuse-switch.  
15  
16           5.     The electrically programmable circuit of claim 4, further comprises a feedback  
17    connection from an output of said electrically programming & sensing unit to said scan chain.  
18  
19           6.     The electrically programmable circuit of claim 4, wherein said electrically  
20    programming & sensing unit comprises:  
21           a diode such that a cathode of said diode is connected to a VDD power;  
22           an electrically programmable element with a first end connected to an anode of said  
23    diode and to said VPP power;

1 a pull-down transistor configured to conduct current from said VDD power or from  
2 said VPP power to ground through said electrically programmable element when turned on;  
3 a latch configured to latch a value from a second end of said electrically  
4 programmable element; and  
5 a multiplexor configured to:  
6 receive said program\_enable signal and said signal from said scan chain; and  
7 output a signal which follows said signal from said scan chain to said pull-  
8 down transistor upon activation of said program\_enable signal.

9  
10 7. The electrically programmable circuit of claim 6, wherein said multiplexor is  
11 further configured to:

12 receive said power-on-reset signal; and  
13 output a signal which follows said power-on-reset signal to said pull-down transistor  
14 upon deactivation of said program\_enable signal.

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16 8. The electrically programmable circuit of claim 6, wherein said electrically  
17 programmable element has an initial state that is one of high resistance and low resistance  
18 and has a programmed state that is the other of said high resistance and said low resistance.

19  
20 9. The electrically programmable circuit of claim 8, wherein a turn-on resistance  
21 of said pull-down transistor is substantially at least 10 times of said low resistance and is  
22 substantially at maximum  $1/10^{\text{th}}$  of said high resistance.

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1           10.     The electrically programmable circuit of claim 6, wherein said pull-down  
2 transistor is an NMOS transistor

3  
4           11.     The electrically programmable circuit of claim 4, wherein said fuse-switch  
5 comprises:

6           a fuse; and

7           a transistor configured to conduct current through said fuse when activated.

8  
9           12.     The electrically programmable circuit of claim 11, wherein said transistor of  
10 said fuse-switch is one of NMOS, PMOS, and bipolar transistor.

11  
12           13.     The electrically programmable circuit of claim 4, wherein said scan chain  
13 comprises a plurality of flip-flops.

14  
15           14.     A field-repairable system-on-a-chip (SOC) device, comprising:

16           at least one of a plurality of redundant rows and a plurality of redundant columns,  
17 wherein each of said redundant row or said redundant column includes a plurality of fuse  
18 boxes;

19           a plurality of usage indicators configured to indicate that corresponding redundant  
20 rows or corresponding redundant columns are in use;

21           a fuse map sensing circuit configured to sense and save data of said plurality of usage  
22 indicators; and

23           a fuse map scan chain configured to send out data sensed by said fuse map sensing  
24 circuit.

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2           15.     The field-repairable SOC device of claim 14, wherein each of said fuse boxes  
3 for said redundant rows and said redundant columns includes:

4           a fuse-switch; and

5           an electrically programming & sensing unit configured to control said fuse-switch.

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7           16.     The field-repairable SOC device of claim 14, wherein each of said usage  
8 indicators comprises a fuse.

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10          17.     The field-repairable SOC device of claim 14, wherein said fuse mapping  
11 circuit comprises:

12           a latch configured to latch value of said usage indicator; and

13           a transistor configured to cause said latch to latch the value of said usage indicator.

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15          18.     The field-repairable SOC device of claim 14, further comprising:

16           a high voltage generator configured to supply a VPP power in response to a  
17 program\_enable signal;

18           a scan chain configured to receive address bits indicating of word and bit lines that  
19 should be corrected; and

20           a plurality of electrically programmable circuits, wherein each of said electrically  
21 programmable circuit comprises:

22           an electrically programming & sensing unit configured to receive a signal

23           from said scan chain, said program\_enable signal, and a power-on-reset signal such

24           that upon activation of said program\_enable signal, said electrically programming &

1 sensing unit further configured to be programmed in response to said signal from said  
2 scan chain indicating a defective row or column should be fixed; and  
3 a fuse-switch configured to receive an output of said electrically programming  
4 & sensing unit such that said electrically programming & sensing unit is able to  
5 activate/deactivate said fuse-switch.  
6

7 19. The field-repairable SOC device of claim 18, wherein said electrically  
8 programming & sensing unit comprises:

9 a diode such that a cathode of said diode is connected to a VDD power;  
10 an electrically programmable element with a first end connected to an anode of said  
11 diode and to said VPP power;

12 a pull-down transistor configured to conduct current from said VDD power or from  
13 said VPP power to ground through said electrically programmable element when turned on;

14 a latch configured to latch a value from a second end of said electrically  
15 programmable element; and

16 a multiplexor configured to:

17 receive said program\_enable signal and said signal from said scan chain; and  
18 output a signal which follows said signal from said scan chain to said pull-  
19 down transistor upon activation of said program\_enable signal.  
20

21 20. The field-repairable SOC device of claim 19, wherein said multiplexor is  
22 further configured to:

23 receive said power-on-reset signal; and

1                   output a signal which follows said power-on-reset signal to said pull-down  
2                   transistor upon deactivation of said program\_enable signal.

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4                   21.     A method to package a field-repairable system-on-a-chip (SOC) device at a  
5                   factory, comprising:

6                   repairing said SOC device, using one or both of redundant rows and columns, prior to  
7                   packaging said device;

8                   marking usage of all redundant rows and columns;

9                   retesting said SOC device; and

10                  packaging said SOC device in response to said SOC device completing said retesting  
11                  step satisfactorily.

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13                  22.     The method of claim 21, wherein said repairing step comprises performing  
14                  laser blown repairs on said redundant rows and columns.

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16                  23.     The method of claim 21, wherein said marking step comprises blowing usage  
17                  indicators corresponding to said redundant rows and columns.

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19                  24.     A method to field repair a field-repairable system-on-a-chip (SOC) device at a  
20                  factory, comprising:

21                  performing a diagnostic test on said SOC device;

22                  identifying unused redundant rows and columns;

23                  electrically programming any of said unused redundant rows and columns; and

24                  retesting said SOC device.

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